Wildlife and Technology

No matter what animal a researcher is studying there are several means by which they can collect data. Some data collection techniques are very simple, such as visual observation, while others are very complex, like DNA analysis. Each technique helps a researcher answer questions about their study subject. Astonishing new technologies have given researchers incredible ways of understanding their subject, and have allowed them to find answers to many new questions.

Tracking

Tracking animals is a simple technique, just follow the footprints. This allows researchers to see precisely where animals travel, estimate populations of small mammals, such as the American Marten, and observe some behavior such as scent marking and hunting patterns.

This method does have limitations. It can only be done when there is adequate snow cover, and must be done 24-48 hours after a snowfall. The amount of area that is covered is also limited by the tracking technique. Snowshoes only allow researchers to cover a small area and snowmobiles, while allowing for a larger area to be covered, are often limited by the terrain.

Observation

Direct field observation is one of the inexpensive methods of collecting data, and can provide insight into the life history of an animal which other methods can not. While this method requires great expenditures of time, observing an animal in its natural habitat allows it to behave naturally.

This method is more effective at certain times of year in Algonquin for certain animals. Wolves are best observed in the spring when they are at a den site or during the summer when they are at a rendezvous site. Here the pack will stay put for several weeks until the young pups are large enough to travel and hunt with the pack. This time allows for social interactions and behavior to be observed between pack members. Direct field observation is not practical other times of the year as wolves are constantly on the move.

Observing birds at certain times of the year help Park Naturalists monitor populations. During the spring and fall bird sightings are monitored daily to keep track of annual arrival and departure dates. In December of each year, the Christmas Bird Count is used to monitor the number and frequency of winter species. Feeder watches, designed to monitor the number of species and individuals coming to winter feeders, are also performed by Park Naturalists. All these methods provide long term monitoring of species diversity, frequency and population.

For Moose the best time to observe their behavior is during the fall rut (mating season). It is during this time that dominance behavior between bulls, and the intricate courtship between cows and bulls, can be studied. Dr. Tony Bubenik discovered, through observing bulls during the rut, that the purpose of antlers is to show how strong and healthy a bull is to other bulls, and to prospective mates. Further observation of Moose in Algonquin Park has also indicated that not only is the size and shape of the antlers important in establishing dominance amongst males, but so is the positioning and movement of the head.

Calling

It is also during the rut that Moose, particularly bulls, can be called in by vocal imitations. The use of vocal imitations is a valid and important resource tool and can be used on a variety of animals. The vocal imitation of a cow Moose will entice bulls into an area where rutting behavior can then be observed.

Vocal imitation is an important tool for bird monitoring. Spring and fall bird monitoring, and Christmas bird counts in Algonquin, keep track of annual arrival and departure dates and winter species. By pishing, squeaking and imitating owls, a naturalist can bring in birds that would otherwise go unnoticed.

Play back of recorded bird songs can be used for monitoring specific bird species. In Algonquin Park during the spring an owl survey is done to establish variations, abundance, and distribution of species. Owls are primarily nocturnal, and roost in concealed locations during the day, thus making them difficult to count. The technique of playing back tape-recorded songs is very useful for owls, which can not be reliably censused otherwise. Because owls are territorial, playing back songs in a territory may bring about a vocal or visual response, in reaction to a possible intruder in the territory. This method is effective to survey the number of owl species, abundance, and distribution in the Park.

Howling for wolves for research purposes began in Algonquin Park during the late 1950s by Dr. Doug Pimlott. In the early years of wolf research the only way to effectively keep track of wolf populations, and locate den and rendezvous sites, was through playback of tape-recorded wolf howls. The equipment was bulky, cumbersome, and impractical for field work. It was eventually discovered that wolves would respond to human imitations. This was a great breakthrough for wolf research in the Park as it allowed Dr. Pimlott, and his researcher team, to more effectively locate packs during the summer months. It also required no equipment and no great technique on the howler's part. Howling is still used today to locate packs at den sites and rendezvous sites and has provided valuable insight on the social and communicative importance howling has within a pack.

Aerial Observation

Aerial observation is often used for collecting data on populations of larger animals, such as Moose, wolves, and beaver. Aerial observations for Moose and wolves are only done during the winter when it is easy to spot and follow tracks and count the number of animals. Beaver surveys are done by Park Naturalists and biologists in the late fall. This is the best time of the year as movement and changes in population have ceased and present colonies remain intact over the winter. Slightly different methodology needs to be utilized when estimating beaver populations, as beavers spend most of their time in or under the water, or in their lodge, and are too small to be spotted when on land. The number of lodges, food piles, active ponds, and differing forest types are use to estimate the number of active colonies. These aerial observations are more effective than ground surveys as researchers are able to cover a larger area over a shorter period of time.

Estimating large mammal populations is not exact. There is no accurate way researchers and biologists in Algonquin Park can calculate precise numbers. The size of the Park, and the fact that animals often travel several kilometres a day, are limiting factors. The best that can be done is to take a survey and estimate the population of any given species. On a basic level this consists of dividing Algonquin Park into grid sections, randomly selecting a number of grids to survey, flying transects in each grid looking for tracks that are then followed to individual animals. A calculation can then be done to estimate the size of a given population.

For Moose surveys, 57 random plots are chosen, 34 in the west side and 23 in the east side. Each plot is 10km by 2.5km, and the total represents less than 20% of Algonquin Park. The surveyors fly low over each plot in parallel lines, making four to five passes looking for moose tracks. When tracks are spotted they are followed to the Moose which are aged, sexed, counted, and location recorded on a map. The researchers are then able to calculate an estimated Moose population for the Park.

Present day wolf researchers are using the Sampling Unit Probability Estimator (SUPE) to estimate the Algonquin wolf population. Approximately half the Park is divided into 137 5x5 km blocks. These blocks are then ranked as having either a high or low possibility of fresh wolf tracks. A portion of the blocks is sampled with researchers following tracks and counting wolves. Once all the blocks are surveyed, the population can be estimated by using complicated mathematics in relation to the spatial distribution of track patterns on fresh snow. It is calculated that the estimated wolf population in Algonquin Park is about 2.0-3.4 wolves/100km^2 (± 25%) during the winter.

Scat Analysis

Scatology, the analysis of scat, or feces, is an invaluable tool to help researchers determine what an animal has been eating, and how an animal's dietary habits vary from season to season, or under certain conditions. Although studying scat can only answer limited questions, it is an important tool for studying large predatory animals, such as bears and wolves.

The analysis of wolf scat has shown researchers that wolves in Algonquin depend on different prey at different times of the year. Beaver, while preyed on from May to October, are preyed on more frequently in the fall. The reason for this increase of predation in the fall is largely due to beavers being more active on land gathering food for the winter. During the winter, deer are the favoured prey of wolves, and movement of packs closely follows the migration of deer out of the Park. Moose also comprise a portion a wolf's diet, but it has been discovered that Moose are largely scavenged by wolves.

Apart from telling researchers what wolves are eating, scats can also reveal how much of each species makes up a portion of the animals diet. In early wolf research in Algonquin (1958-65) conducted by Dr. Pimlott, it was discovered that the annual diet of Algonquin wolves was approximately 80% deer, 8% Moose, 7% beaver and 5% other. The diet changed during the winter, becoming predominantly deer (98%) with the other 2% consisting of Moose and beaver.

During the mid-1970s researchers observed that diet of Algonquin's wolves had begun to change. The annual percentage of deer in the diet of wolves had dropped from 80 to 33 percent. This was attributed to the changing forest conditions, which did not provide suitable habitat for deer. At the same time the amount of beaver being consumed had jumped dramatically from 7 to 55%. The White-tailed Deer though, continued to be the dominant prey through the winter, making up 64% of the wolves' diet, with Moose and beaver making up 17 and 12% respectively. While beaver was now making up a larger portion of the diet of wolves, the analysis of scat during the summer from rendezvous sites, and elsewhere, showed a large variation in the amount of beaver being taken. Scat tested from rendezvous sites showed that beaver made up 64% of prey and scat away from rendezvous sites showed beaver and White-tailed deer made up 35 and 37% respectively. Researchers concluded that the reason for the larger concentration at rendezvous sites was due to the fact that most rendezvous sites were adjacent, or close to active beaver colonies.

Recent studies by Dr. John Theberge, between 1987 and 1992, found a drastic change in the wolves' diet. Dr. Theberge found through scat analysis that the diet of Algonquin wolves consisted of 25% White-tailed Deer, 32% beaver and 37% Moose, of which 71% was scavenged, and 6% other species. The reason for this dramatic shift in prey was due to the changing forest in Algonquin which had become less suitable for deer, which prefer a younger, more open forest. It was also found that the amount of deer being consumed in winter had taken a sharp decline, making up only 23% of the diet. At the same time the amount of Moose and beaver had increased to represent 39 and 31% of the winter diet.

Necropsy

Necropsy, studying carcasses of your research subject, is a valuable tool for researchers. By examining carcasses, researchers are able to discover information that would be hard to obtain from living subjects. Age can accurately be determined by removal of a tooth which, when prepared in the lab, can have the rings counted like a tree. This method is more accurate than examining wear patterns, often done on living animals, such as deer and Moose, as diet and other factors may affect the amount of wear.

Morphological examinations of skeletons also provide clues to researchers of an animal's variation and evolution. Early research, which examined the skulls of Algonquin Park wolves and compared them to skulls of other wolves in Ontario, lead researchers to classify them as a subspecies of the Gray Wolf (*Canis lupus*), known as the Eastern Grey Wolf (*Canis lupus lycaon*).

Studying a carcass also gives researchers a picture of the overall health of an animal. Parasite load is one sign that researchers look at. With Moose they are susceptible to winter ticks, and can often indirectly lead to death. Moose carcasses that show moderate to heavy hair loss are a sure sign of bad winter tick infestation which has lead the Moose to inadvertently rub its protective winter hair off while trying to relieve the irritation of the ticks. The loss of hair eventually leads to death through exposure.

Other health indicators are signs of arthritis, gum disease, injury, and fat content. The fat content in bone marrow of Moose carcasses has helped wolf researchers in Algonquin determine what part of the Moose population wolves are preying on. A large portion, 71%, of the Moose that wolves feed on is being scavenged. It was found in tick-related Moose deaths the carcasses had an average fat content of 44%, and Moose killed directly by wolves had an average fat content of 33%. In comparison, Moose that were killed by humans, i.e. hunting, had an average fat content of 84%.

Live Trapping

While studying the carcasses of a species may be beneficial to researchers, it is ultimately the live subjects that researchers want to study. Live trapping is a large part of any research and it is vital in obtaining immediate and long term data. The method of live trapping depends on the animal being studied. Moose are too large to be trapped, but can be tranquilized from the air or ground. Large animals, like Black Bears, are caught in culvert traps, wolves in either a leg hold trap or snare. Smaller animals, such as adult Gray Jays, may be caught in a cage trap, fish with seine nets, and amphibians with pitfall traps or drift fences.

Immediate data can be obtained from live trapping. Weight, age, and physical condition can be determined. Blood samples can be taken to be analyzed for disease, parasites, and DNA analysis.

Live trapping is a precursor to other techniques, such as radio collaring, tagging, and banding, which will provide researchers with long term data.

Identification and Monitoring Devices

Long term monitoring, tracking, and identification of animals is important in providing researchers with data on movement, eating habits, habitat selection, and population fluctuations. These can be achieved through several different methods.

Leg banding is one of the simplest monitoring methods and is used for Gray Jay research in Algonquin Park. Gray Jays are one of the few birds that stay in Algonquin year round. Gray Jays do not need to be monitored with a transponder as they are relatively confined to the 60-70 acres of their territory. Because territories may overlap, and the birds may venture into another territory, and because it is hard to distinguish neighbouring individuals, leg bands are used to identify each bird. Every bird in the study area is fitted with a colour combination of four bands, two on the left and two on the right leg.

Tagging is often used on animals either as a primary or a secondary identification method in conjunction with radio collaring. Nylon rototags have been used by researchers in Algonquin on

Moose and bears, and small, metal tags are used on wolves. Turtles will often have a metal tag, or 'license plate', attached to their shell. Tags are a valuable means of secondary identification in the event that an animal loses a radio transmitter.

Tagging animals is also used for mark and capture and recapture purposes to estimate population sizes. This is largely used for fish, amphibian and small mammal populations, which cannot be readily observed. Tagging methods vary from species to species. Fish are tagged with dorsal "streamer" tags, amphibians are often toe clipped, and some, like frogs, are given tattoos, and others are fitted with PIT tags.

PIT tags (Passive Integrated Transponders) are small, about the size of a grain of rice, and provide electronic identification of an animal. They are injected into the animal by a syringe, and stay with it for life, without the worry of it becoming worn, lost, altered or unreadable. The tag is read with a hand held scanner which displays the ID number. The transponders are passive, which means they do not have batteries, and are only activated when they are hit with radio waves from the scanner. Since they have no batteries the transponders never wear out.

Radio telemetry is a means of keeping track of an animal that is difficult to locate and observe. Telemetry transmitters can be used on any size of animal. They emit a beeping signal which is picked up by using a receiver. Used for long term monitoring, they last up to six years. Monitoring can be done on the ground, with a limited distance of one to two kilometres, and in the air, which allows for a wider range of coverage, upwards of 15 kilometres. Telemetry devices allow researchers to effectively locate individual animals that would otherwise be impossible to locate. The radio signals permit researchers to monitor an animal at anytime of the year without actually observing it. Besides providing location, transmitters can also tell researchers if the animal is moving, inactive or dead.

Radio telemetry has been used on several research projects in Algonquin Park. Black Bears were fitted with radio collars in order to observe their seasonal movement patterns and feeding habits. Moose have been collared in order to determine calving site selection and for population ecology. Radio telemetry was first used in Algonquin Park for wolf research in 1963 and continues to be used in current wolf research.

New Technologies

DNA Analysis

DNA analysis in wildlife research is relatively new, only being used in the past twenty years. There are several ways wildlife researchers can obtain DNA samples from animals. Live trapping permits researchers to acquire blood or hair samples for DNA analysis. Hair traps also allow researchers to obtain hair samples without having to actually handle the animal. While this method may produce a large number of samples, more than one sample may be left by an individual, thus not providing a good range of samples. DNA can also be extracted from the feces of an animal, which is a non-intrusive way of obtaining samples.

The analysis of DNA allows wildlife researchers to obtain answers to questions that were previously unknown. While the process of analyzing DNA may be slow and tedious it offers a new window into the ecology of Algonquin animals.

One of the most important discoveries about Algonquin wolves comes from DNA analysis. The wolves of Algonquin are generally smaller, and differ in colouration than more northern wolves. For years it was believed that wolves in Algonquin Park were Gray Wolves (*Canis lupus*), just a smaller subspecies. Through morphological comparisons, researchers in the 1970s concluded that the wolves in the Algonquin area were a sub-species of the Gray Wolf, which became known and accepted as the Eastern Gray Wolf (*Canis lupus lycaon*). Of this sub-species of Gray Wolf researchers further classified it into three types, Boreal type, in the northern and boreal forests, the Algonquin type, in the deciduous-coniferous forest, and a Tweed type, found at the southern range of the Algonquin type.

The view that Algonquin wolves were just a smaller species of the Gray Wolf was accepted for many years until DNA analysis contradicted all previous evidence and beliefs. In the late 1990s Paul Wilson from Trent University, and Brad White from McMaster University, examined the genetic makeup of wolves from Algonquin Park.

They discovered that Algonquin wolves were not a sub-species of the Gray Wolf as had been previously believed. The DNA analysis showed that the wolves in Algonquin Park are genetically more closely related to the endangered Red Wolf (*Canis rufus*) in the southern United States. The researchers named the 'new wolf' the Eastern Wolf (*Canis lycaon*). Initially it was believed that the Eastern Wolf was unique to Algonquin. Subsequent research has shown that the Eastern Wolf ranges from Quebec City in the east, through the Algonquin Park area, and as far west as southern Manitoba and northern Minnesota.

Further DNA research is helping researchers answer questions about the uniqueness and developmental history of Algonquin Park wolves. This analysis will also establish the interrelatedness genetically of individual pack members or members of dissimilar but nearby packs.

GPS Collars

In 1994, the first animal-based Global Positioning System (GPS) was introduced to the world of wildlife research. GPS technology automatically records an animal's location through a receiver in a standard telemetry collar, which simultaneously receives signals from four satellites. Movement information is stored in a computer chip inside the collar, along with times and dates of the locations, and the estimated accuracy of the locations. Specified in advance by the researcher, data collection can be set at regular intervals of 15 minutes or longer.

Because each GPS reading draws battery power, collar life varies with interval length. The current generation of collars can record between 2000 and 90 000 locations, making the life expectancy 20 days with fifteen-minute intervals, and up to a year if the interval is two hours.

There are four main methods of data storage and retrieval that researchers can use in GPS telemetry; on-board storage for later collar retrieval and subsequent downloading, remote downloading to a portable receiver, remote relaying through a satellite system, and remote relaying through a mobile radio network or Global System for Mobile Communication (GSM). Each one of these methods of data storage and retrieval has its advantages and disadvantages.

On-board Storage

Collars with only on-board storage capabilities minimize efforts of researchers and invasiveness to the animal since only one handling is required. Once attached, the collar with stay with the animal until an automatic or remotely triggered drop-off mechanism releases the collar, which can then be retrieved. The data then can be downloaded all at once from the collar. Another advantage is the relatively small size of the on-board storage collars, as they contain relatively smaller circuitry and are less complex than other types of GPS collars, and thus, can carry heavier, longer-lasting batteries for the same overall collar weight.

On-board storage collars are less expensive since they are less complex, and require less hardware, such as special field receivers. As well, collars with remote or automatic release or drop-off mechanisms are advantageous because after retrieval they can be refurbished and reused.

The main disadvantage when using an on-board-only GPS unit is data loss. If a collar fails to release, all data is lost unless the animal can be recaptured. As well, since there are no intermediate data reports, the collar could malfunction and not collect data, or may collect data at the wrong intervals. Some collars contain Very High Frequency (VHF) beacons that alert researchers to the status of the last location attempt. However, the beacon indicates only that the unit appears to be functioning properly and does not transmit any data. Consequently, if the collar is not retrieved then all data is lost.

Remote Downloading

The second method of data retrieval is remote downloading to a portable receiver. This method ensures that at least partial data recovery will occur even if the collar malfunctions and fails to release from the animal. Data is remotely downloaded directly to the researcher throughout the study period. The collar is programmed to transmit data through a VHF signal to the researcher’s receiver.

Researchers can receive reports as infrequently as once per week or up to five times per day. This timely retrieval of data allows researchers to supplement the location information with field data. For example, if location data from a wolf indicated that the animal spent a large amount of time in a concentrated area then that may indicate the location of a kill. The researcher can then try to find the kill using a hand-held GPS unit.

A very important feature with this type of GPS unit is long-term data retention following remote data transmission. While intermittent reports are valuable to researchers in allowing data analysis throughout the study, long term, on-board storage allows researchers to fill in any blanks when the collar is retrieved.

Some disadvantages to this method include the relative increase in complexity of the collar which contributes to the weight and cost of the telemetry unit and receiving equipment. As well as higher costs, it takes additional labour to retrieve the intermediate data reports.

Satellite Relay

The third method of data retrieval and storage for GPS telemetry uses a satellite system to relay the intermittent data reports. The researcher is not required to be in the field to collect the data reports or maintain special receivers and additional equipment.

A main disadvantage of this method includes the added bulk and weight of the telemetry unit since transmitting to satellites takes more power. The added weight limits the size of animal that can tolerate this type of GPS unit.

Global System for Mobile Communications (GSM)

The fourth method of data retrieval, which was introduced in March 2002, is through a mobile radio network known as the Global System for Mobile Communications (GSM). This method is similar to mobile phone service as the data is sent as a Short Message Service (SMS). The coordinates of an animal's location are sent directly by a GSM modem that is integrated into the GPS collar to a researcher's office, where they can be transferred by computer to a digital map.

There are several advantages of having a GPS-GMS collar. The researcher does not have to be in the field to collect the data as it is sent directly to their office through an SMS. The researcher also has the option of receiving data in real time by choosing to receive data after each GPS fix. This allows the researcher to track an animal from the office in a time-saving, environmentally-sound, and inexpensive manner.

A main disadvantage of a GMS system is that the animal has to be in an area where GMS coverage is available in order for data to be transmitted. Data will continue to be stored while the animal is out of the coverage area but can not be transmitted until the animal is back in the coverage area. Thus, if a researcher has chosen to receive data after each GPS fix they may experience large gaps in their data sets.

Compared to conventional radio telemetry collars there are several advantages and disadvantages that GPS units possess. The most apparent advantage of the GPS collar is the large amount of data that can be collected. A good data set for traditional radio telemetry is around 200-300 locations while GPS collars can provide ten to 300 times that number.

GPS collars are more expensive than conventional collars ($3000 compared to $250), but overall research costs are considerably lower. The most expensive part of radio telemetry studies involves collecting the data, which includes personnel time, flight time, and vehicle expenses. With GPS collars the data is collected automatically so other expenses are largely avoided. GPS collar expense can be reduced further by replacing batteries and reusing the collars.

GPS collars allow researchers to obtain data on an animal’s location in any weather, as frequently as every minute or as infrequently as once per week. They also provide greater accuracy than conventional collars, at least when conventional collars are tracked from the ground rather than from an aircraft. Location errors with conventional telemetry can be half a kilometre or more. GPS locations are accurate to within 100 metres, 95 per cent of the time, and can be made accurate to within 5 metres.

Another advantage is the data obtained from GPS collars provide good approximations of routes traveled by animals and information about activity patterns. With GPS data, and a Geographic

Information System (GIS) program, it is possible to 'connect the dots', add the lengths of these lines, and total the distances traveled at different times of day. This is possible with conventional radio telemetry but requires extensive around-the-clock field time and associated location errors would make comparisons less meaningful.

One apparent disadvantage of GPS collars is, while they provide increased accuracy, the longevity is much less than that of conventional radio telemetry collars. Depending on the frequency of the intervals for data collection, a GPS collar will last only between 20 days and a year, whereas conventional telemetry collars can last up to four years. Batteries can be replaced on GPS collars giving them longer field life but this involves locating and recapturing the animal.

The cost of collars is another factor. Costing nearly ten times as much as conventional telemetry collars this can limit the number of individual animals being tracked. If there is a reduced sample size within the study unit this can cause data-analysis problems when generalizing about a population.

The quantity of data that can be acquired with GPS collars will make some questions easier to address than in the past. For example, GPS and GIS data can show how dispersing wolves use the landscape. How often, and when, do dispersing wolves cross Highway 60 in Algonquin Park? How closely do they approach man-made structures and campgrounds? How often do they travel on logging roads and for how long?

The challenge in GPS telemetry may prove to be in the analysis of so much data. But for many researchers who are studying elusive animals, such as the wolf, which are often studied with relatively small telemetry data sets, this will be a very welcome challenge.

Geographic Information Systems (GIS)

Maps have always contributed invaluable information to wildlife research projects, lending graphic support to research proposals, queries, and conclusions. Clear cartographic images are excellent communicators and research tools, yet traditional maps have always been limited in data representation. Paper maps are limited to flat, static images, representing a particular moment in time. The evolution of the digital map and Geographic Information Systems (GIS) dramatically changed the nature of spatial data representation.

A GIS is composed of a detailed digital map image that consists of a virtually unlimited number of data layers, each of which may represent various groups of features (e.g., soil type layer, vegetation layer, political boundary layer). Each feature of a digital map has the potential to be linked to characteristic data that relates to that feature.

There are several advantages to using GIS in wildlife research. It allows for a smooth integration of field research data from a wide variety of sources and media. Location data from a GPS-GMS collar can be downloaded in a researcher’s office daily where it can be transferred by computer to a digital map.

Related data linked to mapped features allow researchers access to an unlimited wealth of information. It also allows for the production of cost-effective maps, charts, tables, and reports to support research objectives.